

CLAIMS

What is claimed is:

1. A back-end integrated circuit (IC) manufacturing assembly comprising:
5 a front-of-line portion comprising a plurality of integrated sub-stations for operating on a first plurality of die-strips on an in-line basis to produce a second plurality of die-strips;

an end-of-line portion coupled to said front-of-line portion and comprising a plurality of integrated sub-stations for operating on said second plurality of die-strips
10 on an in-line basis to produce die-strip components;

an in-line test portion coupled to said end-of-line portion for testing said die-strip components; and

a finish portion coupled to said in-line test portion and comprising a plurality of integrated sub-stations operating on tested die-strip components.

2. The assembly as described in Claim 1 wherein one of said plurality of sub-stations of said front-of-line portion is an in-line plasma sub-station.

3. The assembly as described in Claim 1 wherein one of said plurality of sub-stations of said front-of-line portion is a snap cure sub-station.

4. The assembly as described in Claim 1 wherein said plurality of sub-stations of said front-of-line portion comprise:

an in-line die attach sub-station for attaching dies to a strip to produce said
25 first plurality of die-strips;

an in-line cure sub-station;

a first in-line plasma sub-station;

an in-line bond sub-station; and

a second in-line plasma sub-station.

5. The assembly as described in Claim 4 further comprising camera systems for performing automated die-strip inspection and quality assurance at said die attach and bond sub-stations.

6. The assembly as described in Claim 1 wherein said plurality of sub-stations of said end-of-line portion comprise:

- an in-line mold sub-station;
- an in-line post mold cure sub-station;
- an in-line solder ball attachment sub-station;
- an in-line sawing sub-station; and
- a sorting sub-station.

7. The assembly as described in Claim 6 further comprising camera systems for performing automated product inspection and quality assurance at said mold, solder ball attachment and sorting sub-stations.

8. The assembly as described in Claim 1 wherein said plurality of sub-stations of said finish portion comprise:

- a marking sub-station;
- a final visual inspection sub-station; and
- a tape and reel sub-station.

9. The assembly as described in Claim 1 wherein said front-of-line portion is coupled to said end-of-line portion to provide said second plurality of die-strips to said end-of-line portion in an in-line fashion.

10. The assembly as described in Claim 1 wherein said end-of-line portion is coupled to said test portion to automatically provide said die-strip components to said test portion.

5 11. The assembly as described in Claim 1 wherein said test portion is coupled to said finish portion to automatically provide said tested die-strip components to said finish portion.

12. An IC back-end manufacturing assembly comprising:
10 a front-of-line portion comprising a plurality of sub-stations for operating on a plurality of die-strips in an in-line basis commencing with an in-line die attach sub-station and ending with a in-line plasma sub-station; and
an end-of-line portion automatically receiving processed die-strips from said front-of-line portion in an in-line fashion and comprising a plurality of sub-stations
15 for operating on said processed die-strips in an in-line basis commencing with an in-line mold sub-station and ending with a sort sub-station.

13. An assembly as described in Claim 12 further comprising:
an in-line test portion automatically receiving die-strip components output
20 from said in-line sort sub-station and for testing said die-strip components; and
a finish portion coupled to said in-line test portion and comprising a plurality of sub-stations operating on tested die-strip components output from said in-line test portion and commencing with a marking sub-station and ending with a tape and reel sub-station.

25 14. The system as described in Claim 12 wherein one of said plurality of sub-stations of said front-of-line portion further comprises another in-line plasma sub-station.

15. The system as described in Claim 14 wherein one of said plurality of sub-stations of said front-of-line portion is an in-line snap cure substation.

16. The system as described in Claim 15 wherein one of said plurality of sub-stations of said front-of-line portion is an in-line bond substation.

17. The system as described in Claim 12 further comprising a camera system for performing automated die-strip inspection and quality assurance at said in-line die attach sub-station.

18. The system as described in Claim 12 wherein said plurality of sub-stations of said end-of-line portion further comprise:
an in-line post mold cure sub-station coupled to said in-line mold sub-station;
an in-line solder ball attachment sub-station; and
an in-line sawing sub-station coupled to said sort sub-station.

19. The system as described in Claim 18 further comprising camera systems for performing automated product inspection and quality assurance at said mold, solder ball attachment and sorting sub-stations.

20. The system as described in Claim 13 wherein said plurality of sub-stations of said finish portion further comprise a final visual inspection sub-station coupled between said marking sub-station and said tape and reel sub-station.

21. An apparatus for automatically performing back-end fabrication of an IC device comprising:

(a) a die attach module adapted to attach a plurality of IC die to a substrate under computer control;

(b) a bonding module adapted to bond wires to both the substrate and the attached die under computer control;

(c) a molding module adapted to encapsulate bonded die and substrate with a mold material under computer control;

5 (d) a singulation module adapted to separate encapsulated, bonded die and substrate under computer control into separated die;

(e) a testing module adapted to test the separated die under computer control; and

10 (f) a plurality of transporters adapted to automatically transport: (i) the substrate and the attached die from the die attach module to the bonding module; (ii) the bonded die and substrate from the bonding module to the molding module; (iii) the encapsulated, bonded die and substrate from the molding module to the singulation module; and (iv) the separated die from the singulation module to the testing module.

15 22. The apparatus as described in Claim 21 further comprising (g) an automated machine vision system adapted to inspect at least two of: (i) the substrate and the attached die; (ii) the bonded die and substrate; (iii) the encapsulated, wire-bonded die and substrate; and (iv) the separated die.

20 23. The apparatus of Claim 21 wherein said transporters comprise a plurality of conveyors.

25 24. The apparatus of Claim 22 further comprising a marking module adapted to mark the tested die under computer control.

25 25. The apparatus of Claim 24 wherein the automated machine vision system is further adapted to inspect the marked die.

26. The apparatus of Claim 24 wherein the transporters are further for automatically transporting the tested die to the marking module.

27. The apparatus of Claim 24 further comprising a packaging module
5 adapted to package the tested die under computer control to produce packaged die.

28. The apparatus of Claim 27 wherein the automated machine vision system is further adapted to inspect the packaged die.

10 29. The apparatus of Claim 27 wherein the transporters are further for automatically transporting the tested die to the packaging module.

30. The apparatus of Claim 27 wherein the packaging module comprises a tape and reel module.

31. The apparatus of Claim 21 further comprising a snap curing module adapted to snap cure an adhesive adapted to attach the plurality of die to the substrate.

20 32. The apparatus of Claim 21 further comprising an in-line plasma cleaning module adapted to plasma clean the substrate and attached die.

33. The apparatus of Claim 21 further comprising an in-line plasma cleaning module adapted to plasma clean the bonded substrate and die.

25 34. The apparatus of Claim 21 wherein the singulation module comprises a sawing module.

35. The apparatus of Claim 21 wherein the substrate comprises an n-by-m

matrix array ball grid array (BGA) substrate and wherein n and m each independently being an integer of at least 2.

36. The apparatus of Claim 21 further comprising a sawing module adapted to saw wafers under computer control to provide said separated die.

37. An apparatus comprising:

(a) an in-line die attach module adapted to attach a plurality of IC die to a substrate under computer control;

(b) an in-line bonding module adapted to bond wires to both the substrate and the attached die under computer control;

(c) an in-line molding module adapted to encapsulate the bonded die and substrate with a mold material under computer control;

(d) a plurality of transporters adapted to automatically transport:

(i) the substrate and the attached die from the die attach module to the bonding module, and

(ii) the bonded die and substrate from the bonding module to the molding module; and

(e) an automated machine vision system adapted to inspect at least two of: (i) the substrate and the attached die; (ii) the bonded die and substrate; and (iii) the encapsulated, bonded die and substrate.

38. An apparatus as described in Claim 37 further comprising an in-line plasma module coupled between said die attach module and said bonding module.

39. An apparatus as described in Claim 38 further comprising an in-line snap cure module coupled between said die attach module and said plasma module.

40. An apparatus comprising:

(a) a die attach module adapted to attach a plurality of IC die to a substrate under computer control;

(b) a molding module adapted to encapsulate the substrate and attached die with a mold material under computer control;

5 (c) a testing module adapted to test the molded substrate and die under computer control;

(d) a plurality of transporters adapted to automatically transport:

(i) the substrate and the attached die from the die attach module to the molding module, and

10 (ii) the molded die from the molding module to the testing module; and

(e) an automated machine vision system adapted to inspect at least one of: (i) the substrate and the attached die; and (ii) the molded die and substrate.

15 41. An apparatus as described in Claim 40 further comprising an in-line plasma module coupled between said die attach module and said molding module.

42. An apparatus as described in Claim 41 further comprising an in-line snap cure module coupled between said die attach module and said plasma module.

20 43. An apparatus comprising:

(a) a bonding module adapted to bond wires to both a substrate and a plurality of die attached to the substrate under computer control;

25 (b) a molding module adapted to encapsulate the bonded die and substrate with a mold material under computer control;

(c) a singulation module adapted to separate the encapsulated, bonded die and substrate under computer control into separated die;

(d) a plurality of transporters adapted to automatically transport:

(i) the bonded die and substrate from the bonding module to the molding module; and

(ii) the encapsulated, bonded die and substrate from the molding module to the singulation module; and

5 (e) an automated machine vision system adapted to inspect two or more of: (i) the bonded die and substrate; (ii) the encapsulated, bonded die and substrate; and (iii) the separated die.

10 44. An apparatus as described in Claim 43 further comprising an in-line plasma module coupled to said bonding module.

45. An apparatus as described in Claim 44 further comprising an in-line snap cure module coupled to said plasma module.

15 46. An apparatus comprising:

(a) an in-line bonding module adapted to bond wires to both a substrate and a plurality of die attached to the substrate under computer control;

(b) an in-line molding module adapted to encapsulate the bonded die and substrate with a mold material under computer control;

20 (c) an in-line testing module adapted to test the separated die under computer control;

(d) a plurality of transporters adapted to automatically transport:

(i) the bonded die and substrate from the bonding module to the molding module; and

25 (ii) the encapsulated, bonded die and substrate from the molding module to the testing module; and

(e) an automated machine vision system adapted to inspect at least one of: (i) the bonded die and substrate; and (ii) the encapsulated, bonded die and substrate.

47. An apparatus as described in Claim 46 further comprising an in-line plasma module coupled to said bonding module and further comprising an in-line snap cure module coupled to said plasma module.

5 48. An apparatus comprising:
 (a) a molding module adapted to encapsulate a substrate and a plurality of die bonded to the substrate with a mold material under computer control;
 (b) a singulation module adapted to separate the encapsulated, bonded die and substrate under computer control into separated die;
10 (c) a testing module adapted to test the separated die under computer control;
 (d) a plurality of transporters adapted to automatically transport:
 (i) the encapsulated, bonded die and substrate from the molding module to the singulation module; and
 (ii) the separated die from the singulation module to the testing
15 module; and
 (e) an automated machine vision system adapted to inspect at least one of: (i) the encapsulated, bonded die and substrate; and (ii) the separated die.

20 49. An apparatus as described in Claim 48 further comprising an in-line plasma module coupled to said molding module.